THE AMERICAN MINERALOGIST

JOURNAL OF THE MINERALOGICAL SOCIETY OF AMERICA

VOL. 10 JANUARY, 1925 No. 1

HOEGBOMITE FROM VIRGINIA[1]

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INTRODUCTION

Based on microscopic study of thin sections of the magmatic iron ores from the Routevare region, Lapland Axel Gavelin[2] published in 1916 a comprehensive paper on the occurrence of "a new rock-forming mineral," which he named hoegbomite in honor of Professor A. G. Högbom of the University of Upsala. According to Gavelin the hoegbomite occurs chiefly in the iron-rich but silicate-free types of the iron ores. In addition to the predominant minerals, magnetite and ilmenite, hoegbomite is associated with pleonaste and corundum, and subordinate hydrargillite and pyrrhotite. Amphibole and chlorite sometimes occur as minor silicate constituents.

The present paper directs attention to the occurrence of hoegbomite in the spinel emery of the Virginia area[3] located near Whittles, a station on the main line of the Southern Railway, in Pittsylvania County. Thus far hoegbomite has not been reported outside the Routevare area, hence its occurrence in this country is not without interest.

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* While this article was going through the press announcement was made of the sudden death of Dr. Watson on November 10, 1924. A memorial sketch is being prepared by Professor Ries which will appear in an early issue of this journal.—EDITOR.

[1] Presented at the Washington meeting of the Mineralogical Society of America, December 29, 1923.

[2] Hoegbomite: A new rock-forming mineral from the Routevare area in Lapland. *Bull. Geol. Inst., University of Upsala*, **15**, 289-316, 1916.

[3] Watson, Thomas L., and Steiger, Geo.: Titanium-bearing corundum spinellite (rock emery); a preliminary statement of its occurrence and composition in Virginia. *Jour. Wash. Acad. Sci.*, **8**, 665-676, 1918.

Watson, Thomas L.: A contribution to the geology of the Virginia emery deposits. *Econ. Geol.*, **18**, 53-76, 1923.

HOEGBOMITE FROM THE ROUTEVARE AREA, LAPLAND

The properties of hoegbomite from Lapland as determined by Gavelin are summarized below.

PHYSICAL PROPERTIES.—Color in thin sections brown, in grains or powder black and not distinguishable from the principal associated minerals. Cleavage parallel to the base, not well defined. Brittle, conchoidal fracture, luster metallic-adamantine. $H = 6.5$ and sp. gr. about 3.81. Weakly magnetic. Hexagonal (rhombohedral). Sometimes idiomorphic with well developed prismatic and pyramidal faces; base usually best developed. Axial ratio, $a:c = 1:1.56$. Twinning parallel to the base; sometimes repeated.

OPTICAL PROPERTIES.—Refraction and double refraction strong. Refractive indices: $\omega = 1.853$; $\epsilon = 1.803$; double refraction: $\alpha - e \doteq 0.050$. Basal sections isotropic. Uniaxial, negative (−). Pleochroism distinct, suggesting biotite but weaker; $e =$ light yellow-brown, $\omega =$ dark brown; absorption: $\omega > \epsilon$.

CHEMICAL PROPERTIES.—Insoluble in acids. An analysis calculated to 100% on an SiO_2-free basis gave:

ANALYSIS OF HOEGBOMITE FROM THE ROUTEVARE REGION, LAPLAND

	Per cent	Ratios	
TiO_2	5.53	.069	.069
Al_2O_3	61.19	.600	.711
Fe_2O_3	17.41	.109	
Cr_2O_3	0.29	.002	
MgO	15.44	.386	.388
MnO	0.14	.002	
	100.00		

From this analysis Gavelin deduced the formula $RO.2R_2O_3$, with TiO_2. The analysis shows the same constituents as pleonaste, except that TiO_2 is larger in amount. No appreciable amount of water is present and the iron occurs in the *ic* form (Fe_2O_3). Chemically the mineral represents a pleonaste with slightly increased MgO, and the FeO oxidized and partly replaced by TiO_2. Gavelin interprets the mineral as a mixture equivalent to 60 per cent of the micaceous iron group and 40 per cent of magnesium spinel; being closest physically to the former, but chemically to the spinel group.

Like the associated pleonaste and corundum, Gavelin regards the hoegbomite as a primary magmatic mineral, but states that in some cases it gives the impression of having been secondarily formed at the expense of pleonaste.

HOEGBOMITE IN THE VIRGINIA EMERY[4]

In a recent petrographic study of the Virginia emery, the writer noted a brown mineral, rather abundant in some thin sections and absent in others, whose optical properties correspond reasonably well with those determined by Gavelin for hoegbomite.

The Virginia emery[5] is a corundum-bearing magnetite spinellite. It is a dense and black fine-grained interlocking aggregate of green spinel (pleonaste-hercynite), ilmenitiferous magnetite, and corundum, with more or less of the brown mineral hoegbomite. Silicate minerals are usually lacking in the high grade emery, except for chlorite developed marginally about the emery bodies and scant sillimanite as fine fibers in the emery. Except for occasional segregations of coarse corundum the minerals of the emery are megascopically indistinguishable, and for most of the rock are less than 0.1 mm. in diameter, but in the coarsest textured emery they may reach 2 mm. in size.

Green spinel is the predominant mineral and frequently makes up 50 per cent or more of the rock. It carries inclusions both of magnetite and corundum, the former being frequently so abundant as to obscure the substance of the spinel. It frequently shows distinct rims of a brown cryptocrystalline material, identified as the mineral hoegbomite. Magnetite ranks next to spinel in quantity but is usually much less abundant. It is developed both interstitially and as inclusions in the spinel and corundum. It is partly older and partly younger than spinel. The older magnetite forms fine almost dust-like inclusions in spinel, while the younger or second generation is in distinct crystal grains up to 0.4 mm. in diameter (Plates I and II).

Corundum exceeds magnetite in some slides but is absent in others, being subject to wide variation in amount. It bears no relationship to hoegbomite. Inclusions of spinel and magnetite

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[4] It is a pleasure to make grateful acknowledgment to Dr. C. S. Ross of the U. S. Geological Survey, for kindly measuring the refractive indices of the hoegbomite and for helpful suggestions made during the course of this study.

[5] For a discussion of the geology, including occurrence, composition, structure, etc., of the emery, see Watson, Thomas L., A contribution to the geology of the Virginia emery deposits, *Econ. Geol.*, **18**, 53-76, 1923.

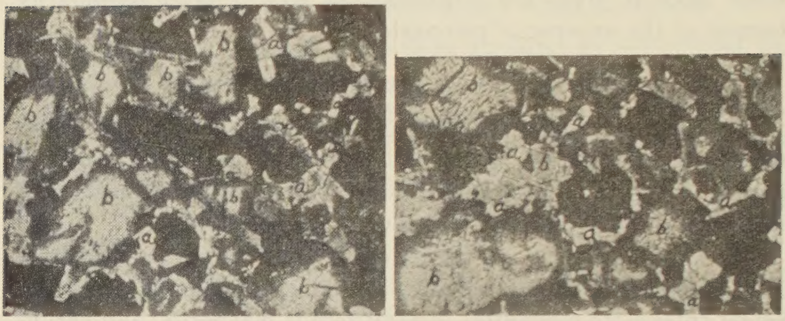

Plate I. Microphotographs of Virginia rock-emery showing hoegbomite: (a) crystalline hoegbomite of prismatic habit and cryptocrystalline hoegbomite as brown borders rimming (b) spinel with magnetite inclusions. Black areas magnetite. (C. S. Ross, Photo.)

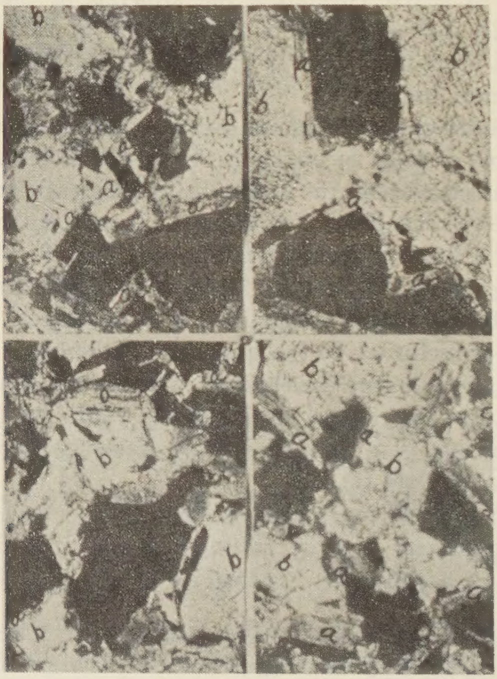

Plate II. Microphotographs of Virginia rock emery showing hoegbomite: Same as Plate I. Observe in each plate intimate relationship in some cases of the crystalline prismatic hoegbomite and the cryptocrystalline brown borders of hoegbomite about spinel. x52. (J. K. Roberts, Photo.)

occur in it, the latter being so abundant at times as to nearly obscure the substance of the corundum. Hoegbomite is absent from many of the thin sections. It is intimately associated with the spinel and magnetite, but not with the corundum. The crystalline type is older than the interstitial or second generation magnetite and the cryptocrystalline type which occurs as brown rims bordering spinel is younger than the latter.

The ratios of the above minerals vary widely. Likewise the paragenesis of the minerals seems not to be a definite one, but is subject to variation. Frequently the order is magnetite (first generation as inclusions in spinel and corundum), corundum, spinel, hoegbomite, and magnetite (second generation as interstitial crystal grains).

The ore-bodies occur near the intrusive contact of granite with mica schists, and are intimately associated with granite pegmatites. They occur both in the schist and in the granite and are of igneous contact metamorphic origin.

HOEGBOMITE.—The brown mineral (hoegbomite) in the Virginia spinellite is developed in microscopic size only, and is never visible megascopically. Moreover it is not a constant constituent of the rock, but is absent from many thin sections studied and fairly abundant in others. From a large number of measurements made, the mineral varied in size between 0.03 mm. and 0.003 mm. in length, and 0.010 and 0.002 mm. in width, with an average of 0.012 mm. (length) and 0.005 mm. (width). It is intimately associated with spinel and magnetite, but not with corundum. Indeed it has its chief development in those thin sections which contain little or no corundum.

Optically, the brown mineral in the Virginia rock agrees fairly closely with the description of hoegbomite given by Gavelin[6] and has been so identified. It is regretted that a chemical analysis of the hoegbomite in the Virginia rock has not been made, for it would be of special value in this study.

As developed in the Virginia rock, hoegbomite occurs in two forms, each brown in color, with at times an undoubted transition from one form to the other shown. One form is composed of crystalline material, usually prismatic in habit, occurring in euhedral shapes as single individuals and aggregates, sometimes as shreds and irregular grains. Cross fracture is sometimes developed. The mineral is most intimately associated with spinel and magnetite both interstitially and as inclosures, but usually exhibits sharp contacts molded against the other minerals both of which are primary. Since the interstitial or second generation magnetite is an original mineral in the rock, the euhedral relations of the crystalline hoegbomite, which is older than interstitial magnetite, must also be original or primary.

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[6] *Op. cit.*, pp. 289-316. Attempts to secure some of the Routevare material for comparative study have proved thus far unsuccessful.

The mineral is insoluble in acid. Refractive indices[7]: $\omega=1.848$, $\epsilon=1.817$; double refraction: $\omega-\epsilon=0.031$, a lower value than that given by Gavelin for the original mineral from the Routevare region. Uniaxial, negative $(-)$. Pleochroism somewhat variable; ϵ = light yellow brown to nearly colorless, ω = dark brown; absorption $\omega>\epsilon$. Basal cleavage; general appearance micaceous.

The other form of hoegbomite is developed as alteration rims or borders about the spinel individuals into which they grade, but outwardly are sharply molded against the other minerals, especially magnetite. It is an alteration from spinel, and is composed of cryptocrystalline material of fairly high birefringence and a mean index of 1.850 ± 0.01, as determined by Dr. Ross. This is a little higher than the mean of the crystalline material, but, as Ross states, "this is to be expected as it includes limonitic pigment. In measuring the index one gets an aggregate effect that does not quite represent the value for pure cryptocrystalline material."

In many cases where the crystalline and cryptocrystalline hoegbomite are in contact, transition from one to the other is observed microscopically, the cryptocrystalline material becoming more crystalline toward the outer edge and the two areas frequently extinguishing together. The cryptocrystalline material composing the brown rims is definitely derived from spinel, but whether it represents *alteration* subsequent to complete crystallization of the rock rather than true *reaction rims* developed after spinel formed but before crystallization was complete, the writer is in doubt. Concerning the latter, Ross has properly raised the question whether the alteration may "have been a deuteric phenomenon followed by crystallization of residual magma into the crystalline hoegbomite and interstitial magnetite."

There are certain microscopic features of the cryptocrystalline material composing the brown rims which when considered singly might readily be explained on the basis of either of the above explanations. For the following reasons chiefly, the writer has been inclined to regard the brown rims as alteration subsequent to complete crystallization of the rock: (1) the material composing the brown rims shows an irregular inner margin which gradually fades inwardly into the substance of the spinel as contrasted with usually a sharp outer margin molded against the magnetite, etc.; (2) the inclusions of minute black granules of magnetite which usually crowd the substance of the green spinel also occur at times in the substance of the brown rims.

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[7] Measured by Dr. C. S. Ross, U. S. Geological Survey, Washington, D. C.

On the other hand, magnetite as well as spinel is an original mineral in the rock and, since crystalline hoegbomite which shows euhedral relations to magnetite is older than magnetite, it must also be original. Again since the cryptocrystalline substance of the brown rims is transitional into the crystalline hoegbomite, it likewise must have developed earlier than the interstitial magnetite. Whether it started with the alteration of spinel and ended with the crystallization of crystalline hoegbomite, or whether it began with crystallization of the former and ended with the alteration of spinel is an open question.

Spinel with magnetite inclusions crystallized ahead of both hoegbomite and magnetite. The magnetite inclusions so abundant in much of the spinel and to some extent in the substance of the brown rims must have crystallized ahead of the other minerals. This means that two generations of magnetite developed in the rock. Based therefore on the above paragenetic relations of the minerals, the brown borders of cryptocrystalline material might be readily explained as true reaction rims formed after crystallization of spinel but before final crystallization of the rock. In either case it was a deuteric process.

Composition of the Lapland and Virginia spinel

The occurrence of hoegbomite both in Lapland and in Virginia, is in spinel-bearing rocks of igneous origin. In the Lapland rock spinel is subordinate to magnetite; in the Virginia rock it is the dominant mineral with magnetite subordinate. For purposes of comparison chemical analyses showing the composition of the spinel from Lapland and Virginia are as follows:

ANALYSES OF SPINEL FROM LAPLAND AND VIRGINIA

	Lapland	Virginia
SiO_2	0.38	0.92
TiO_2	0.11	0.67
Al_2O_3	61.23	53.52
Fe_2O_3	3.80	10.35
FeO	20.10	24.53
MgO	13.82	10.02
H_2O	0.16	———
	99.60	100.01

Recalculated on a 100 per cent SiO_2-free basis and transformed into molecular percentages of the compounds $MgAl_2O_4$, $FeAl_2O_4$, and $FeFe_2O_4$, the analyses yield the following results:

	Lapland	Virginia
$MgAl_2O_4$	49.56	35.93
$FeAl_2O_4$	44.72	48.20
$FeFe_2O_4$	5.80	15.08

The spinels are thus shown to be mixtures of the same molecules but in different proportions. Magnesium aluminate (spinel proper) molecules predominate in the Lapland spinel, while ferrous aluminate (hercynite) molecules are predominant in the Virginia mineral; the former corresponds to pleonaste, the latter more closely approaches hercynite.

CONCLUSIONS

Optical properties of the crystalline and cryptocrystalline brown material described above, together with the microscopic evidence of transition from one to the other, are reasonable proof of their similarity mineralogically, and they are therefore identified as the mineral hoegbomite.

The paragenetic relations of the crystalline hoegbomite of prismatic habit to magnetite, an original mineral, indicate that it is also an original constituent of the rock and is older than magnetite. If this is correct, the crystalline hoegbomite in the Virginia rock is a primary mineral as determined by Gavelin for the mineral of the Routevare district.

The cryptocrystalline material composing the brown borders of the spinel is a distinct alteration of spinel probably of the reaction rim type formed after the crystallization of the spinel, but before complete crystallization of the rock and was a deuteric process. Its transitional relations to the crystalline hoegbomite are in accord with this view. That somewhat similar relations were recognized by Gavelin for hoegbomite from the Routevare district is indicated in the statement on page (3 ms.) "that in some cases it [hoegbomite] gives the impression of having been secondarily formed at the expense of pleonaste."

SCHALLERITE, A NEW ARSENO-SILICATE MINERAL FROM FRANKLIN FURNACE, NEW JERSEY

R. B. Gage, Esper S. Larsen, and Helen E. Vassar, *Harvard University*

Introduction.—The new mineral herein described is a hydrous arseno-silicate chiefly of manganese. It was discovered by one of the authors, Mr. R. B. Gage, during the early part of 1924 and apparently has been mistaken for bustamite or rhodochrosite, which material in the massive form it resembles a great deal. The specimens secured were small pieces attached to the massive ore; yet, no doubt, this material occurred in considerable quantity, but unfortunately on account of its resemblance to some of the other minerals found at Franklin Furnace, no effort whatever was made to collect it. Consequently, it was crushed with the other zinc ores in the mill. The name *schallerite* is proposed for the mineral after Dr. Waldemar T. Schaller, of the United States Geological Survey, Washington, D. C.

Occurrence.—To date no crystals of schallerite have been seen but the massive material is fairly pure and appears uniform in chemical composition and physical properties. It is light brown with a vitreous, waxy luster. The fractured surface shows cleavage planes with pearly luster.

It can easily be distinguished from willemite, bustamite, rhodonite, rhodochrosite, or friedelite, for which it might be mistaken, by its behavior with acids, also in the closed tube, and by its optical properties. The arsenic coating in the neck of the closed tube is very characteristic. This test together with its appearance is sufficient to identify it.

Schallerite occurs in seams or on cleavage faces in the massive zinc ore. The thickness of these seams is from one-half inch to two inches, and, judging from the appearance of the specimens secured, may cover several square feet. The mineral is firmly attached to the massive ore and its surface is often covered with a thin coating of white calcite. The specimen secured came from about seven hundred feet beneath the surface, evidently from a locality in the mine that is impregnated with arsenic. Chlorophoenecite[1], another arsenic mineral, comes from this same locality.

PHYSICAL PROPERTIES.—The physical properties and general appearance of schallerite are very similar to those of massive friedelite, but friedelite has a conchoidal fracture while the fracture surfaces of schallerite show numerous small cleavage faces with a pearly luster. Schallerite has a hardness of 4½ to 5 and a specific gravity of 3.368.[2]

In the closed tube schallerite gives off water at a fairly low heat, and upon increasing the heat to a dull red, forms an arsenic coating in the neck of the tube. Under the blow-pipe it turns black and fuses on the edge to a dark brown bead.

Schallerite is nearly colorless in powder, is uniaxial negative, and has a perfect basal cleavage. The indices of refraction are: $\omega = 1.704$, $\epsilon = 1.679$.

CHEMICAL PROPERTIES.—Schallerite is slowly decomposed by hot hydrochloric acid leaving a residue of granular silica.

A chemical analysis was made by Miss Vassar on a sample that was shown by the microscope to have only traces of impurities.

The mineral was decomposed by aqua regia to insure the oxidation of the arsenic. The silica was dehydrated by two evaporations with HCl and all but a negligible amount of the other elements dissolved. Arsenic was precipitated as sulphide in 1:1 HCl solution, dissolved in ammonium hydrogen peroxide and determined finally as $Mg_2As_2O_7$. After evaporation of the excess acid and oxidation of the iron an attempt was made to separate manganese from the iron by the basic acetate method. As this proved unsuccessful with such a small amount of iron, the iron was precipitated with NH_4OH, twice reprecipitated, and filtered rapidly to free it from the manganese. The manganese and zinc were precipitated as sulphides leaving the magnesium in the filtrate to be determined in the usual manner. Some manganese which passed into the filtrate was recovered in the magnesium precipitate by the bismuthate method. The precipitate of MnS and ZnS was dissolved in acid; the manganese precipitated thrice as NH_4MnPO_4, the first two precipitations in an excess of NH_4OH to keep the zinc in solution. Zinc was precipitated in the filtrate as $ZnNH_4PO_4$, after boiling off the excess NH_4OH.

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[1] Foshag, Wm. F. and Gage, R. B., A Preliminary Description of Chlorophoenecite, *J. Wash. Acad. Sc.*, 14, 362-363, (1924).

[2] The specific gravity calculated by the law of Gladstone and Dale using the mean index of refraction and the values of k given by Larsen is 3.44. See Larsen, E. S., The Microscopic Determination of the Nonopaque Minerals. *U. S. Geological Survey, Bull.* **679**, 1921, pp. 30-31.

Water was determined by the Penfield method. Some of the arsenic sublimed in the tube along with all the condensed water and both were weighed, but instead of driving off the water in the usual way with a bunsen burner, it was dried out in an oven at 110°, which left the arsenic.

ANALYSIS AND RATIOS OF SCHALLERITE

		MOLECULAR RATIOS		THEORETICAL COMPOSITION
SiO_2	31.20	.5174	9×.0575	31.0
As_2O_5	13.81	.0601	1×.0601	13.1
MnO	44.20	.6234	12×.0583	48.7
FeO	1.33	.0184		
MgO	2.13	.0528		
ZnO	.39	.0047		
H_2O (total)	6.93	.3850	7×.0550	7.2

The analysis is very close to $12MnO.9SiO_2.As_2O^5 .7H_2O$ or $9MnSiO_3.Mn_3As_2O_8.7H_2O$.

The composition is similar to that of friedelite, the chlorine being replaced by arsenic.

Schallerite $9MnSiO_3.Mn_3As_2O_8.7H_2O$
Friedelite $9MnSiO_3.MnCl_2.7H_2O$

Both schallerite and friedelite are uniaxial negative and both have a perfect basal cleavage.

Schallerite is related chemically to dixenite but contains much more silica and less arsenic.

SUMMARY.—Schallerite occurs at Franklin, New Jersey, seven hundred feet below the surface in veinlets an inch or more across, cutting the normal zinc ore. It is massive, light brown in color, and has a vitreous to waxy luster. It has a hardness of 4½ to 5, a specific gravity of 3.368, and is difficultly fusible. In the closed tube it gives off water at a low heat and an arsenic coating at a dull red heat. It has a perfect basal cleavage, is uniaxial negative, and $\omega = 1.704$, $\epsilon = 1.679$. It has the composition $12MnO.9SiO_2.As_2O\text{-}._5$ $7H_2O$.

AN OCCURRENCE OF XONOTLITE AT LEESBURG, VIRGINIA[1]

Earl V. Shannon, *U. S. National Museum*

The calcium silicate, first described as eakleite and later shown to be identical with xonotlite by Larsen[2], has been found recently as the product of solutions, emanating from diabase, upon Triassic limestone conglomerate, at Leesburg, Loudoun County, Virginia. The minerals and the metamorphic effects at this locality have been described by the present writer in a paper to appear in the Proceedings of the U. S. National Museum.

The first specimen of this mineral obtained from this locality was picked up as a loose mass on the floor of the quarry by Dr. Waldemar T. Schaller while on a visit to the locality accompanied by Dr. Larsen, Mr. Frank L. Hess and the writer.

The xonotlite forms rounded patches, up to 5 or 6 centimeters in diameter, surrounded by rims from 1 to 4 millimeters wide of cross-fibered pale bluish-green material which is largely calcite mixed with some fibrous silicate. After this material is treated with cold dilute acid there remains a residue of fibers of very low birefringence and refractive index below 1.50, which may be silica from the decomposition of wollastonite fibers. The interstices between the xonotlite areas are filled with pearly granular wollastonite.

This xonotlite, like those previously described from other localities, is densely fibrous and very tough. When freshly broken the mineral is distinctly pink in color and somewhat translucent but upon exposure to air the pink color gradually fades and the pieces become opaque and chalky in appearance. A selected fragment from the center of one of the purer masses was analyzed yielding the results given in column 1 of the following table. This was not, however, of very pure material as it was shown by microscopic examination to contain two admixed minerals amounting to several per cent. The most abundant of these was apparently diopside, the second probably thaumasite. The xonotlite, under the microscope, is finely fibrous with parallel extinction and positive elongation. The refractive indices are somewhat variable, the average being $\alpha=1.580$, $\gamma=1.592$. The xonotlite mass was found on the floor on the eastern wall of the quarry near the basalt dikes. None of this type of material could be found on subsequent visits.

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[1] Published by permission of the Secretary of the Smithsonian Institution.

[2] E. S. Larsen. Eakleite, a new mineral from California. *Am. J. Sci.*, **43**, 464-465 (1917). The identity of eakleite and xonotlite. *Am. Min.*, **8**, 181-182 (1923).

When the members on the field trip of the Mineralogical Society of America visited this locality following the Christmas, 1923, meeting, a very different form of xonotlite was found in thin seams in relatively unaltered limestone in the north end of the quarry. This was available in considerable amounts and specimens were collected by Samuel G. Gordon, Chester B. Slawson, F. R. Van Horn and others of the party. This material forms veinlets up to 5 mm. wide filled with flaky fibrous xonotlite with pearly luster and pale pinkish color which greatly resembles the coarser varieties of pectolite. The feel is harsh and needles break off and enter as splinters in the fingers like pectolite. The xonotlite is mixed with calcite and some of the fissures appear to have an earlier layer of datolite next to the wall. The needles form radiating bundles and rosettes on the crack-surfaces, sometimes 3 cm. across. Under the microscope these lie on a perfect cleavage which is probably perpendicular to the obtuse bisectrix. If this be taken as the *b*(010) face the optical orientation is $X=b$, $Y=a$, $Z=c$. The elongation of the needles is positive and they give parallel extinction. The mineral is thus biaxial and positive, probably with 2V small. The refractive indices are $\alpha=1.583$, $\beta=1.583$, $\gamma=1.595$. The analysis of this material is given in column 2 of the following table.

ANALYSES OF XONOTLITE FROM VIRGINIA

	1 Compact	2 Coarse	3 Theory. $5CaSiO_3.H_2O$.
SiO_2	45.62	49.60	50.16
Al_2O_3	2.05	1.00	——
CaO	41.28	46.32	46.82
MgO	2.26	——	——
$H_2O+110°C$	6.00	2.80	3.02
$H_2O-110°C$	1.00	none	——
Total	98.21	99.72	100.00

DANBURITE FROM LA SIRENA, NEAR ZIMAPAN, MEXICO

W. Kupferbürger, *Massachusetts Institute of Technology*

In a paper[1] on a deposit of jamesonite at La Sirena near Zimapan, Mexico, W. Lindgren and W. L. Whitehead described the occurrence of the mineral danburite in a recrystallized and somewhat metamorphosed limestone in contact with a basic dike. It occurs as one of the gangue minerals together with calcite, quartz, grossularite, albite, fluorite and actinolite.

Their description is believed to be the first on record of the occurrence of danburite in Mexico. Subsequently another occurrence of this mineral from Guadalcázar has been described.[2]

In the material from La Sirena, given the writer by Dr. Lindgren for examination, the danburite was associated with jamesonite, calcite, fluorite and quartz. It was colorless, transparent and granular but in places there were some elongated crystals in rudely parallel intergrowths. None of these, however, were sufficiently well developed to measure.

The material was finely crushed, suitably screened, and then treated with a heavy liquid in order to eliminate the associated minerals. After repeated treatment the material was found by microscopic examination to be of a sufficient degree of purity for analysis. Some of the grains were colored slightly yellow, presumably by limonite, but no chemical methods such as treatment with dilute acids were employed to clean them.

An analysis by the writer yielded the following:

	La Sirena	Mol. ratios	Theor. comp.	Danbury,[3] Conn.
SiO_2	48.35%	0.801	48.8	48.15
Al_2O_3 and Fe_2O_3	0.23			
CaO	23.07	0.41	22.8	22.37
MgO	trace			
B_2O_3	27.74	0.39	28.4	27.44
Loss on ignition	0.54			0.50
Total	99.93		100.0	98.46

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[1] Lindgren, W. and Whitehead, W. L.: *Econ. Geology*, **9**, 435-462 (1914).

[2] Wittich, W. and Kratzert, I.: Contribuciones a la Min. Mex. *Mem. Soc. Alzate, T.* **39** & **40.**, 1921 and 1922.

[3] Dana, E. S.; A System of Mineralogy, Sixth Ed., p. 492 (1914).

The mineral corresponds, therefore, in chemical composition to $CaO.B_2O_3.2SiO_2$ or $CaB_2Si_2O_8$. It agrees closely in composition with the mineral from the type locality, Danbury, Connecticut, the analysis of which is given for comparison. The loss on ignition in the two analyses probably represents hygroscopic water.

The same material used by the writer for analysis was examined optically. It shows a very low birefringence, is optically negative and has a large optic axial angle, nearly 90 degrees. The minimum and maximum refractive indices were determined by immersion methods, using monochromatic light, as follows: $\alpha_{Na} = 1.630 \pm .001$; $\gamma_{Na} = 1.636 \pm .001$.

On account of the low birefringence of the mineral the value for the beta index was not determined, but since 2V is close to 90 degrees, this value can be assumed to be approximately intermediate between the values for alpha and gamma.

E. S. Larsen[4] gives the values of the indices of refraction of the mineral danburite as follows: Alpha = 1.632; Beta = 1.634; Gamma = 1.636.

The specific gravity of the mineral from La Sirena was determined as 2.93. The values quoted in Dana's System of Mineralogy vary between 2.97 and 3.02.

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[4] Larsen, E. S. The Microscopic Determination of the Non-opaque Minerals: *U. S. Geol. Survey, Bull.* **679**, (1922).

THE CRYSTULE; A UNIT MEASURE OF MATTER

CHARLES KEYES, *Des Moines, Iowa*

Amidst a wealth of stimulating discussion on the different phases of matter which held the rapt attention of the large majority of the members at the recent Toronto Meeting of the British Association for the Advancement of Science, the outstanding prospect was the unit mass and its relationships to the world about it.

It made little difference in what branch of science it happened to be, the fundamental unit of make-up was the prime consideration, whether in description, in discussion or in speculation. Of all the departments of knowledge in which there were read papers aplenty, and over which there was invariably warm controversy, physics, chemistry, biology, astronomy, geology, mineralogy, the last mentioned science alone stood unabashed for want of a crisp, self-defined title for its unit characteristic. This was all the more surprising because of the fact that the idea of a crystal unit consituted the basic concept of the new chemistry, the chemistry of the solid, in strong contradistinction to the chemistry of the liquid, of the last century. This is the chemistry of the geologist, the mineralogist, and the crystallographer.

When science first begins to take on modern aspect its philosophic setting is strictly anthropocentric in character. Earth, our planet, is the central unit of all. Presently, this circumscribed outlook begins to grow in one direction, outwards, giving other basic units of measurement for the phenomena about us, the larger ones for stellar or solar systems and for the universe. In opposite direction, inward, there arises the concept of mass, or mineral, or rock, and beyond the powers of ordinary vision, the molecule, the atom and, finally, the electron. With the growing importance of crystallographic mineralogy, with the optical expression of internal structure, comes the realization that the molecule of our liquid chemistry is not the crystal unit of our solid chemistry.

For this clumsy term, crystal-unit, or unit-cell, or some polyglot phrase, may be substituted some such simple and expressive word as crystallule, or *crystule*, a little piece of ice, which, as the molecule is the smallest portion of a liquid or gas which has all the properties of the whole, is the simplest form of a solid which possesses all the properties of the crystal substance.

The crystule of quartz for instance, we now know, consists not of what the chemist tells us, of a simple molecule of silicon dioxide, but of three such molecules linked together in peculiar fashion. No single molecule of silicon dioxide can possibly be quartz; neither can either of the separate atoms of silicon or of oxygen be quartz. To the application of the X-ray to crystal analysis is due mainly our most recent unprecedented advancement in crystallography and the understanding of the chemistry of the solid; and it is the particular function of this line of inquiry to point out the basic arrangement of the atom and the molecules in the crystule, and to explain the properties of minerals on the basis of such a plan.

So long ago as 1872, in a paper read at the Dubuque Meeting of the American Association for the Advancement of Science, Dr. Gustav. Hinrichs, from purely mathematical calculations, pointed out the fundamental dynamic differences in the make-up of the three states of matter. Because a half century ahead of his times his long forgotten communication to American scientists was little regarded by the men to whom it was presented; but it appears to have really anticipated by a full generation much that we are now hailing with so much delight in the field of crystallography and in the domains of the new solid chemistry.

But be that as it may, crystallographers have a broad and novel field of endeavor before them in the development of crystal tectonics, and in the adjustment of all the long puzzling peculiarities and properties of minerals to the new style of crystal architecture. In the term crystule may be found the basic concept of the new prospect.

PROCEEDINGS OF SOCIETIES

PHILADELPHIA MINERALOGICAL SOCIETY

Academy of Natural Sciences, October 9, 1924

A stated meeting of the Philadelphia Mineralogical Society was held on the above date with the president, Mr. Vaux, in the chair. Twenty-seven members, and eleven visitors were present.

The name of Mr. Albert Hallowell was proposed for active membership. The following officers were elected for 1924-1925: President: Mr. George Vaux, Jr.; Vice-president: Mr. Harry W. Trudell; Treasurer: Mr. Henry Millson; Secretary: Dr. Horace Blank.

Mr. Harold W. Arndt addressed the society on *A Ten-Day Trip to New England Localities.* Mrs. Arndt visited a number of New England localities in company with Mr. R. M. Lane of Great Barrington, Mass. The principal finds exhibited were from Canaan, Mass., tremolite in grayish crystals and white radiating masses in limestone; Lee, Mass., tremolite; Branchville, Conn., spodumene, beryl, and ilmenite; Chester, Mass., emery, diaspore, margarite, tourmaline and corundophilite; Stockbridge, Mass., calcite; Blanford, Mass., beryl; Richmond, Mass., goethite and gibbsite; Litchfield, Mass., cyanite; Granby, Mass., quartz crystals; Great Barrington, Mass., tourmaline; Roxbury, Mass., garnet.

Mr. Biernbaum described an excursion to the Ecton and Perkiomen mines on September 28th, accompanied by Messrs. Wills, Trudell, and Gordon. Calamine, aurichalcite, linarite, pyromorphite, chlorite, and dioptase? (very minute emerald-green rhombohedra) were found. Mr. Hoadley exhibited oligoclase from New York City and apatite from Anthony's Nose, N. Y. Mr. Benge reported on a trip to the Wheatley mines with Mr. Thatcher, where cerussite was found.

Mr. Vaux exhibited a number of striking specimens of apophyllite, natrolite, and calcite from the French Creek mines. The apophyllite was practically a solid mass with one surface covered with large crystals, measuring 28×30 cm. The natrolite occurred as snow white, compact radiations, 8 cm. in diameter, associated with small calcite crystals, forming a vein in crystalline limestone (hanging wall of the orebody). The calcite specimens exhibited resembled natrolite, consisting of white radiations, which are perhaps pseudomorphs after a zeolite. Dr. Wills exhibited a beautiful series of box mounts of the Ecton mine minerals with the aid of a binocular microscope.

Samuel G. Gordon, *Secretary*.

NEWARK MINERALOGICAL SOCIETY

The 67th regular meeting of the Newark Mineralogical Society was held at the home of Mr. Broadwell, as the regular meeting place was not open. President Walther presided, eleven members being present. The minutes of last meeting were read and approved. The applications of Messrs. Karlson, Schairer and Metcalfe were presented for action and all elected to membership. The secretary reported on the Branchville, Conn. outing held on Decoration Day. All who attended this outing were well pleased with the trip. Mr. Broadwell reported having found the following: bröggerite xls; uraconite; eosphorite; torbernite (?); albite; dickinsonite; lithiophilite; hureaulite; fairfieldite (2 forms); natrophilite (?); columbite; quartz xls; apatite; margarosanite; sphalerite; damourite; cymatolite; eucryptite; montmorillonite; spodumene, white and pink; prochlorite; microlite xls; triploidite xls.

The outing for Columbus Day was discussed and finally left to the decision of Capt. Miller. Mr. Hoadley reported visiting 22 localities the past summer. He spoke of finding garnet at Leipersville, Pa.; epidesmine and stilbite at Robinson, Pa.; schallerite at Franklin, N. J.; also chlorophoenicite from the same locality; cobaltiferous pyrite from Cornwall, Pa.; beryl from New Milford, Conn.; apatite in stilbite from Anthony's Nose, N. Y. Mr. Grenzig reported azurite and franklinite from Ogdensburg, N. J.; botryoidal datolite, pink, from Franklin, N. J. Mr. Schmid found benjaminite, realgar with stibnite in cavities at Manhattan, Nevada. Mr. Walther spoke on Branchville, Conn., and reported a new find of native iron from Modoc Co., California.

A vote of thanks was extended to the secretary for the use of his home for the day's meeting. The meeting then adjourned.

Wm. H. Broadwell, *Secretary*.

NOTES AND NEWS

Smithsonite; Kelley Mine, Magdalena Mtns., New Mexico. William P. Headden, *Colorado Agricultural College*. Several years ago Mr. Philip Argall of Denver presented the author with a sample of smithsonite from New Mexico. It forms a layer about ¾ inch thick over a ferruginous, siliceous base. Its color is green, quite deep in the upper portion of the layer. The sample cuts and polishes rather handsomely. The locality is not new. The sp. gr. is 4.4103 at 15 degrees. An analysis shows: CO_2 35.12, ZnO 60.97, CuO 3.48, CdO 0.16, CaO 0.44 with traces of PbO, MnO and FeO.

The Deseret Museum of Salt Lake City, a general geological and biological collection containing one of the largest and most complete mineralogical collections in the West, was presented to the Brigham Young University, Provo, Utah.

The Mineral-Exchange Bureau of the Institute of Economic Mineralogy and Petrography of Leningrad, Russia, has accumulated a large stock of minerals including many that have been discovered during the past ten years and desires business relations with those wishing to obtain specimens for their collections.

In the article on "Mineral Localities in the Vicinity of Middletown, Connecticut," *Am. Min.*, **7**, 4-12, 1922, Professor W. G. Foye listed all minerals then known to occur in this region. He wishes to add to that list *thulite*, which has been found near Walkley Hill in Haddam. It is associated with quartz and lime epidote and occurs as radiated blades showing a very good cleavage. The mineral is pink in color and has an index in the neighborhood of 1.70.

The manuscript for Part 2, Optical Mineralogy by Professor A. N. Winchell, Madison, Wisconsin, is nearly completed. In order that all data of inorganic substances whose optical constants have been measured might be included an appeal is made for all unpublished and published optical data not recorded in Fry's Tables of Groth's Chemische Krystallographie.

Dr. Otto Oldenberg of the University of Göttingen, Germany, gave a lecture at the Massachusetts Institute of Technology on "Phosphorescence and Fluorescence Phenomena."

In order to fill out complete sets of The American Mineralogist the Editor is very anxious to procure, by gift or purchase, certain early issues of the Journal. These numbers include: Vol. I, Nos. 1, 2, 5; Vol. II, Nos. 2, 3, 12; Vol. III, Nos. 1, 3; Vol. IV, Nos. 2, 3, 4, 5, 6. Members are asked to search their files for duplicate copies or approach former members of the Society for these early issues.

One of the specimens brought back from South America by Mr. O. C. Farrington of the Field Museum, Chicago, is a rock crystal with a liquid inclusion estimated to be 10,000,000 years old. The quartz was found at Bon Jesus dos Meiras, Bahia, Brazil.

Dr. Thomas L. Watson, Corcoran professor of geology at the University of Virginia and state geologist of Virginia, known for his contributions to mineralogy, petrology and economic geology, died on November 10, aged fifty-three years. A memorial sketch of the life of Dr. Watson, written by Professor H. Ries of Cornell, will appear in an early issue of this Journal.

A recent find of a flattened diamond crystal weighing 40.22 carats has been announced from Murfreesboro, Arkansas.

Alfred H. Brooks, for twenty years chief of the Alaska division of the United States Geological Survey, died November 21 at the age of fifty-three years.

ABSTRACTS

SCAPOLITE FROM RIVER KANDA. O. O. BAKLUND. *Bull. Acad. Imp. Sci. Petrograd,* [6] **11**, pt. 1, 19-26 (1917); thru *Mineral. Abstr.*, **2**, 126.

Scapolite occurring near the Kanda river, Kemi district, Archangel govt., encloses ankerite, chlorite, albite, and muscovite. The scapolite had (for Na light) ω 1.5700, ϵ 1.5450, and ω 1.5716, ϵ 1.5442. An analysis gave: SiO_2 50.35, Al_2O_3 25.86, Fe_2O_3 0.13, MgO 0.23, CaO 11.96, Na_2O 7.04, K_2O 0.62, CO_2 2.65, SO_3 0.36, Cl 1.03, H_2O 0.25, sum 100.48, corresponding to $49Ma+51Me$. The composition is discussed. The scapolite rocks of this district are metamorphic derivatives of labradorite, which occurs as a monomineral facies of gabbro-norite rocks of the region. E. F. H.

A HEMATITE CRYSTAL FROM THE NEIGHBORHOOD OF SHABRY, NIJNE-ISETSK ESTATE, IN THE URALS. V. V. SYEDELSHCHIKOV. *Bull. Inst. Polytechn. Don* 5, sect. **2**, 25-31 (1916); thru *Mineral. Abstr.*, **2**, 136.

A rhombohedral crystal of hematite from this locality in the Ekaterinburg district, Perm, weighs 1,550 grams and measures 13×9½ ×7 cm. E. F. H.

NEW MEASUREMENTS OF CHONDRODITE FROM VESUVIUS. BOHUSLAV JEŽEK. *Rozpravy České Akad.* cl. 2, **30**, no. 10, 6 pp. (1921); thru *Mineral. Abstr.*, **2**, 139-40.

Four new forms were measured: (241), $(\bar{7}.14.26)$, $(\bar{6}.\ 4.15)$, and $(\bar{5}43)$. Three excellent crystals gave the axial ratios $a:b:c=1.08506:1:3.13937$, $\beta=90°0'$ (vom Rath's orientation). E. F. H.

MINERALS FROM NEAR PELHŘIMOV. JOSEF KRATOCHVÍL. *Časopis Musea Českého*, **95**, 112-8 (1921); thru *Mineral. Abstr.*, **2**, 118.

Aplite dikes near Pelhřimov, s.e. Bohemia, contain dumortierite, andalusite, and tourmaline. Fluorite and pinite pseudomorphs after cordierite occur in quartz veins in this district. Cordierite and green apatite are found in gneiss. As relics of mediaeval mining, argentite, native Ag, and the common sulfides are found at various localities. E. F. H.

OCCURRENCE OF ARGENTIFEROUS ARSENOPYRITE AT ČIHOSŤ NEAR LEDEČ. BOHUSLAV STOČES. *Věda Přírodní*, **3**, 142-3 (1922); thru *Mineral. Abstr.*, **2**, 118.

A quartz vein with arsenopyrite and small amounts of pyrite, galena, sphalerite, and secondary Ag is described . It occurs at Čihosť, Bohemia. E. F. H.

THE BASALT OF THE VINAŘICKÁ HORA. AUGUST ONDŘEJ. *Rozpravy České Akad.*, cl. **2**, 30, no. 48, 9 pp. (1921); thru *Mineral. Abstr.*, **2**, 118.

Thomsonite, chabazite, natrolite, calcite (containing 1.72% MnO), and pyrite fill cavities in a nepheline basalt of this hill, situated between the towns of Kladno and Slané. E. F. H.

NEW OCCURRENCE OF MAGNETITE IN THE PROVINCE OF TOLEDO. J. del Pan. *Bol. R. Soc. esp. Hist. Nat.*, 22, 274-6 (1922); thru *Rev. Géol.*, 4, 478.

Massive magnetite with druses of octahedral crystals occurs at a contact between granite and schist near the village of Ventas con Peña Aguilera.

E. F. H.

MINERALS OF THE GORGE OF LUCKMANIER (BÜNDNER OBERLAND). Leonard Weber. *Bull. suisse Minéral. Pétr.*, 2, 69-77 (1922); thru *Rev. Géol.*, 4, 483.

The minerals discussed are: apatite, aragonite, arsenopyrite, calcite, pyrite, quartz, rutile and siderite. Their crystallography is described. E. F. H.

OBSERVATIONS ON THE QUARTZ CRYSTALS OF THE ALPS. Leonard Weber. *Bull. suisse Minéral. Pétr.*, 2, 276-82 (1922); thru *Rev. Géol.*, 4, 484.

This is a crystallographic study of quartz from Windgällenhütte (Uri) and Galmihorn (Valais). E. F. H.

THE MINERALS OF CATALONIA. Llorenç Tomás. *Treballs Inst. Catalana Hist. Nat.*, Vol. for **1919-20**, 129-357; thru *Mineral. Abstr.* **2**, 116.

The minerals of Catalonia are systematically described, numbering 190 species. A doubtful new mineral was named (in 1914) almeraite, with the formula $KCl.NaCl.MgCl_2.H_2O$, based on the following analysis: KCl 39.03, NaCl 37.13, $MgCl_2$ 15.12, SO_3 0.92, insol. 2.65, H_2O and n.d. 5.15, sum 100. This is a reddish semitransparent granular aggregate from Suria, prov. Barcelona. Bixbyite is noted at Ribes, prov. Girona. E. F. H.

NEW MINERAL OCCURRENCES IN BOHEMIA. Ludmila Slavíková. *Časopis Musea Českêho*, **95**, 125 (1921); thru *Mineral Abstr.*, **2**, 117.

The minerals noted are: barite crystals, from Medový Ujezd; pyrrhotite, Pocínovice; rhodonite, Chvaletice; beryl, Vejrec; molybdenite, Náchod; apatite, dark green, from aplite at Přibyslavice; zinnwaldite, Schlaggenwald; chalcanthite, in quartz vein, Borotice. E. F. H.

THE TELLURIDES, III. T. A. Rickard. *Eng. Mining J. Press*, **114**, 972-3, (1922).

The geographic occurrence, details of discovery, and data on their value as ores are given for the tellurides of Au, Ag, Pb, Ni, Cu, Bi and Hg, and for tellurite.

E. F. H.

A THIRD TYPE OF PROUSTITE FROM COBALT, ONTARIO. A. L. Parsons. *Univ. Toronto Studies, Geol. Sur.*, **14**, 89-90 (1922).

A twin crystal of proustite with entire suppression of the form $(01\bar{1}2)$ from one individual of the twin, while it is present with three well-developed faces on the other. Suggestive of hemimorphic development. A. S. Wilkerson.

ON THE BABINGTONITE FROM THE CONTACT METAMORPHIC DEPOSITS OF THE YAKUKI MINE, PROVINCE IWAKI, JAPAN. MANJIRO WATANABÉ. *Am. J. Sci.* **4,** 159-64, (1922).

At this locality babingtonite is associated with garnet, hedenbergite, calcite, quartz, magnetite, and ilvaite. Fifteen crystals forms were identified, four new for the mineral: j ($\bar{1}02$), l ($\bar{2}02$), q ($\bar{1}11$), z ($0\bar{2}3$). The mineral is black and nearly opaque; strongly pleochroic, X deep emerald green, Y purple brown, Z deep brown. α 1.715, β 1.725, γ 1.740. Biaxial, +. E. F. H.

GEOLOGY OF A VEIN OCCURRENCE OF RUTILE-ILMENITE IN A NEW LOCALITY. THOMAS L. WATSON. *J. Wash. Acad. Sci.*, **12,** 447-54 (1922).-

A rutile bearing quartz vein occurs in Franklin Co., Va. 1 mile west of Teels Mill, in mica schist. The rutile is enclosed in the quartz, as red brown xls., singly and in groups. Primary ilmenite is sometimes intergrown with the rutile, and is sometimes present as an alteration product of that mineral. Analyses of rutile and rutile-ilmenite are given, the first is approx. 5% ilmenite and 95 rutile, the second 40 and 60, respectively. E. F. H.

THE OCCURRENCE OF TELLURIDES IN ONTARIO. E. THOMSON. *Univ. Toronto Studies, Geol. Sur.*, **14,** 91-98 (1922).

Tellurides from Ontario include altaite $PbTe$, coloradoite $HgTe$, petzite $(Ag,Au)_2Te$, hessite Ag_2Te, tetradymite Bi_2Te_3, nagyagite $Au_2Pb_{14}Sb_3Te_7S_{17}$, calaverite $(Au, Ag)Te_2$, and kalgoorlite $HgAu_2Ag_6Te_6$.

A. S. W.

NOTES ON SOME CANADIAN DIOPSIDES. T. L. WALKER and A. L. PARSONS. *Univ. Toronto Studies, Geol. Sur.*, **14,** 74-79 (1922).

Brief crystallographic description of diopside from three Canadian localities; Macdonald Island, Baffin Land; Storrington Township, Ontario; and Hull Township, Quebec.

A. S. W.

TUBULAR AMYGDALOID FROM NOVA SCOTIA. T. L. WALKER and A. L. PARSONS. *Univ. Toronto Studies, Geol. Sur.*, **14,** 5-12 (1922).

In the basalt on the south side of the Bay of Fundy, in Kings and Annapolis counties, there occur vertical pipes or cores. These are of three types: (1) coarsely amygdaloidal, (2) compact cores resembling the general rock mass, (3) tubes more or less hollow, filled or partially filled with quartz or zeolites. The amygdules are largely zeolites. The tubes average ½ inches in diameter and at times at least 2 yards in length. It is suggested that the pipe-like structure is due to the escape thru the lava flow of steam from the underlying rocks.

A. S. W.